MDE Product Development Team
May FY13 Monthly Report
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(Compiled and edited by J. Brown and B. Johnson)

Executive Summary

Task 1: Improve turbulence guidance from NWP forecasts

- RAP summer 2013 configuration implementation continues to run smoothly on Jet (Boulder, RAP primary cycle) and Zeus (Fairmont WV) supercomputers and feeding HRRR. This configuration includes
  -- use of global ensemble information within GSI-based hybrid assimilation procedure for RAP
  -- improved 9-level version of Smirnova Land-Surface Model
  -- specially adapted version of MYNN boundary layer scheme in place of current MYJ scheme
  -- improvements to RAP radar-based hydrometeor building and clearing
- Minor adjustments made to procedure for elimination of precipitating hydrometeors in GSI cloud / precipitation analysis and to alleviate forecast nighttime cold bias over snow-covered areas.
- RAPv2 - ESRL use of hybrid/ensemble data assimilation (with 80-member GFS global ensemble) to specify background error covariance information for real-time parallel RAP marks major step forward, significantly improves RAPv2
- Current upgraded RAP version 2 code built at **NCEP** on new WCOSS computer; machinery for cycling is mostly in place and partially tested; promise of initial parallel testing in near future and possibly accelerated pre-implementation testing and implementation by NCO (now proposed for early FY 2014 after NCEP implementation moratorium is lifted).
- Three real-time parallel RAP cycles (with extensive verification of each) running on Zeus NOAA research supercomputer located in Fairmont, WV to evaluate further likely enhancements to RAP data assimilation / model system for spring 2014 code freeze.
- NCEP making progress on NAM and NAM-nest
- Operational RAP including RAP GSI component successfully ported to new WCOSS machine

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- Ongoing evaluation of HRRR forecast skill for convective system and other parameters; generally good performance on prediction of storms and storm mode on Oklahoma violent tornado days.
- Installation of HRRR test code infrastructure on NCEP WCOSS computer in anticipation of NCEP implementation, possibly early in calendar year 2014.
- Hourly RTMA running again in real-time and progress toward creation of 15-min prepBUFR observation files from GSD NetCDF files.
- Presentation on HRRR at NSSL/SPC/OU by Curtis Alexander and participation by Curtis Alexander, John Brown, and Eric James at SPC Spring Program for experimental forecasting.
- Continued work to test full HRRR (including pre-forecast hour with radar and GSI assimilation) on NCO WCOSS computer to determine resource requirements for possible 2014 implementation.

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

Upgraded physics configuration now running in RAPv2 at GSD, code compiled at NCEP

- 9-level RUC land-surface model: improvement in surface wind forecast and 2-m temperature forecast

- GSD/Olson version of MYNN boundary-layer scheme: improvement in low-level wind forecasts
- Continue use of Grell G3 parameterization of deep convection from WRFv3.2.1.
- Integration of bug correction into RAP/ WRF regarding lack of radiation effects from snow mixing ratio in atmosphere, which has been contributing to a daytime warm bias in the RAP and HRRR at the surface.

Thompson microphysics scheme used in RAP was successfully ported by NCAR and NCEP to the NMMB under NEMS, setting the stage for more collaboration between NCAR and NCEP on microphysics issues in the future.

NCAR is preparing for the 13th Annual WRF Workshop in late June.

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

- Real-time, frozen RAPv2/HRRR system running successfully with gridded field dissemination, real-time web display of graphics and verification of many forecast fields.
- Ongoing monitoring of RAPv2/HRRR system with regards to reliability (including joint reliability with Jet – Zeus failover) and forecast performance.
- HRRR "failover" capability to use feed from Zeus instead of Jet during Jet downtime is working; enhancements necessary to make Zeus completely independent of Jet will come in July.
- Examination of enhanced verification of HRRR convective forecasts, including VIL and echo-top.

Task 1: Improve turbulence guidance from NWP forecasts

Improving turbulence forecast quality involves efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM nests) and to improve the models (WRF-Advanced Research WRF (ARW)-RAP and NOAA Environmental Modeling System (NEMS)- Nonhydrostatic Multi-scale Model – B (NMMB)).

Tasks will include:

- Continuing evaluation of RAPv2 toward early 2014 implementation at NCEP, incorporating changes developed in 2012 and early 2013.
- Collaborating on developing & testing best approaches for use of hybrid/EnKF/3DVAR within common GSI coding structure.
- Collaborating on developing and testing physics schemes between WRF and NEMS' physics layer.
- Negotiating Data Mining List priorities with NCEP Central Operations and external points of contact associated with the most desirable new sources of observations. (NCEP and ESRL)
- Continuing final testing of RAPv3, including initialization of the HRRR.

ESRL

Regarding the NCEP RAP

The operational RAP at NCEP continues to run without any technical problems, including post processing. The RAP continues to show improved reliability over the previous RUC at NCEP; the March UniPost fix to avoid crashes due to spurious decrease in height with decreasing pressure continues to work flawlessly.

As noted in last month's report, good progress has been made toward implementation of RAP on NCEP's new WCOSS computer. During late April and early May, the RAPv2 executable based on the current GSD RAP-primary code were successfully built on WCOSS and new versions of fixed files needed to run RAPv2 were ported to NCEP. Good progress toward setting up the partial cycling was made during May by Ming Hu working with Geoff Manikin of NCEP: cycling using NetCDF format for the files needed in the cycling process is now working; debugging is underway on the scripting for cycling using binary i/o. Prospects are good that a parallel RAPv2 cycle will be running on the WCOSS machine within the next few to several weeks toward pre-implementation testing on the WCOSS computer and a possible NCEP operational implementation of RAPv2 by early FY2014.

Regarding the ESRL RAP

In our last quarterly report we described the summer 2013 RAP and HRRR configurations and the path to their completion. A list of the configuration changes from the summer 2012 versions of the RAP and HRRR can be found **here**. These form a new baseline for testing of candidate future enhancements in RAP and HRRR, which continued during May, using the three development RAP cycles on the Zeus computer. RAP-dev1, identical to the RAP-primary running on the Jet computer, serves as the backup RAP cycle to support the running of the HRRR on Zeus in an identical configuration to the HRRR on Jet. (See more discussion under Tasks 2 and 4 concerning this strategy for improving the reliability of the HRRR.) RAP-dev2 was used in early May for continued evaluation of the Grell-Freitas convection parameterization (see Task 3 for more details). During the 15 May through 15 June period RAP-dev2 is temporarily reserved for examining the impact of special dropwindsonde data being collected over the western CONUS during the Mesoscale Predictability Experiment (**MPEX**). These data are made available to the RAP-dev2 cycle, but withheld from the RAP-primary. RAP-dev3 is being used to examine the impact of bias-correcting temperatures from aircraft observations.

In the April 2013 monthly report we noted two snow-related issues in the RAP. We have conducted many reruns in our attempt to completely understand the excessive snowfall predicted near Omaha on 2 May, but have yet to reach sufficient understanding to introduce modifications that we are confident will do no harm in other situations. The second snow-related issue was a distinct nighttime cold bias in 2-m temperature in areas of snow cover. This was tied to introduction of the MYNN planetary-boundary and surface layer, and the fix for this problem is noted under Task 3.

We are currently assessing consequences of a change to our partial cycling to ensure that the soil temperature and moisture from the ongoing RAP cycle is not replaced by the soil temperature and moisture from the partial cycle at 0900 and 2100z, at which times the atmospheric variables from the partial cycle 1-h forecast are used as the background for the GSI analysis. Also, we will not allow any soil moisture adjustment during the partial cycle.

A modification was made to the GSI cloud / hydrometeor analysis to ensure clearing of all precipitating hydrometeors in model grid columns where there is at least partial radar coverage and these radar reflectivity observations indicate no precipitation and in addition satellite indications are that the model column is free of clouds.

Evaluation of the new GSI cloud analysis enhancements including Effective Cloud Amount (ECA) from the improved CLAVR-x (Clouds from AVHRR [Advanced Very High Resolution Radiometer] Extended) data from NESDIS continued. While some reduction in RH moist bias in the 600-300 hPa range was achieved from these enhancements while building clouds at all levels from GOES data, we decided to hold off their implementation until after the RAP freeze is over in November, pending more evaluation of thresholds to use in determining areas of partial cloudiness (equivalent to METAR SCT or BKN sky cover) and other considerations implied in switching to the CLAVR data.

Haidao Lin continued his work toward obtaining improved results for AIRS satellite radiance assimilation in the RAP.

Other activities, some noted more fully under other tasks, also were undertaken:

- The NCAR WRF developers officially released WRF version 3.5 on 18 April. This included a number of contributions by GSD developers: the latest version of the RUC LSM (Smirnova), the Grell-Freitas deep and shallow convection, the MYNN PBL and surface-layer schemes updated through late December (Olson) and the current version of the RAP digital filter initialization (Peckham and Smirnova). These physics upgrades (with the exception of the GF convection) are already in the v3.4.1 code ported to NCEP for RAPv2.
- Retrospective testing for both RAP and HRRR of the impacts of proprietary in situ tower wind data and other special data continues under funding from the DOE Wind Forecast Improvement Project.
- Biweekly telecons between GSD and the Storm Prediction Center of NCEP continue. The purpose of these telecons is to obtain feedback from SPC on RAP (RAPv2 from GSD as well as the operational v1) and GSD HRRR-primary performance, and to inform SPC of planned Jet and Zeus computer downtimes.

NCEP

Initial tests of RAP V2 began on NCEP's WCOSS system in May. This version of RAP is scheduled to replace the current version in late CY 2013. (Geoff Manikin)

An improved method for maximizing the amount of LaRC GOES cloud data that goes into the RAP analysis was successfully tested, and will be transitioned into the operational ingest in July. (Dennis Keyser)

A parallel RTMA system has been set up to evaluate results from the method of using two separate analyses for land and lake 10-m winds, and the evaluation is underway. The goal is to improve the RTMA wind analysis over the major lakes. RAWS mesonet data dropouts and latency in the RTMA are being investigated. Although there have not been any major dropouts in the last few months, the inconsistency of the arrival time of the data at NCEP is still of concern. Work has been initiated to update the RTMA observation accept and reject lists, which are computed from the RTMA innovation statistics. (Manuel Pondeca, Steve Levine)

Two bugs in WCOSS level2-radar decoder were found and fixed. The decoder could not properly decode raw level2 data when the data header is missing or radial beams at a single elevation are in nonconsecutive order. These bugs caused radar data processing to fail. A significant effort was made to find out why radar data processing jobs take too long to run on WCOSS. The long circuit path caused the data to arrive slowly so NCEP switched to bringing in the raw level2 data in 4 simultaneous streams over the circuit. The radar-processing job was also modified to use 4 computer nodes on WCOSS. These changes brought the radar processing back under the time limit on WCOSS. The GSI was modified to use NASA LaRC cloud data. Comparisons of the NASA versus the NESDIS cloud data were made. Tests were also done on the result from assimilating reflectivity from GSD's cloud analysis package for Feb-May 2013. Precipitation scores for the first 24 hours of the forecast are improved. A slight positive impact was found in the conventional data verification. This will be added to NAM parallel testing in June. (Shun Liu)

The NAM parallel on Zeus was found to have a convergence problem. The cause was discovered to be an ozone analysis that was turned on when the background error for ozone was not properly set. The analysis script was modified to not copy the ozone data file into the run directory. Another convergence problem related to radiosonde level enhancement means this option can't be used. The cause was found to be some radiosonde reports drifting in and out of an MPP sub-domain due to the motion of the balloon. The bogus data produced between the level before it drifts out and the level after drifting back in are inaccurate and caused problems in minimization. Since a fix that would produce consistent bogus data

when the RAOB drifted back into the sub-domain was complicated, it was decided to redo the option and to produce the bogus data when the radiosonde data are read in. The code to fix this problem passed the code-change requirements and was sent to the GSI review committee for approval. (Wan-Shu Wu, Jacob Carley)

CAPS

There isn't much to report for this past month – work can be summarized as below:

CAPS worked on finishing a draft manuscript reporting on the results of hybrid DA system testing.

In the previous quarter, a regional dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data is established. It was found that the 13km forecasts from the dual-resolution hybrid analyses were no better than the 13km forecasts from interpolated EnKF or hybrid analyses performed at 40km grid spacing. The evaluation was limited to 3-hour forecasts before (due to disk spacing issues). During April, the experiments were rerun and forecasts were made up to 21 hours and verification was performed on the fly (to save disk space). The results are somewhat improved, but some variables are still not better. Further comparisons were made between the 40km forecasts from 40km EnKF and hybrid analyses and the 13km forecasts started from the interpolated 40km analyses, and it was found that the RMS errors of the 13km forecasts are larger – this could be the cause of the poor performance of the dual-resolution experiments. The window length differences between the 40- and 13km forecasts, and the high-resolution terrain used on the 13km grid are suspected to be the main causes, and new experiments will be run to isolate the causes.

Additional information on RAP-related tasks

ESRL

GSD continues to make pgrb and bgrb files from the ESRL/GSD RAP-primary (RAPv2) real-time 1-h cycle available from its FTP site for users in NWS and other labs).

NCEP

NCEP maintained real-time availability of SAV and AHP guidance to all vendors from the operational hourly RAP on pressure surfaces via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC&NCO)

NCEP maintained real-time availability of full resolution gridded data from the operational RAP runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/rap/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.rap_CY.00 through MT.rap_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.** Gridded RAP and NARRE [-TL] fields are available on **NOMADS** for the CONUS domain on 13 km grid #130 and the Alaska domain on 11.25 km grid #242. RAP fields are also available for the larger North American domain on 32 km grid #221. A limited set of fields from the RAP runs (and other NCEP models) can also be viewed at **http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller.** (EMC&NCO)

Verification of RAP

ESRL's verification of the RAP is available from **http://ruc.noaa.gov/stats**. NCEP maintained its capability and provided access to routine verifications of the operational RAP analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** .

Deliverables	Delivery Schedule
Task 1 – Improve turbulence guidance from NWP forecasts	
a. Finalize code for RAPv2 for implementation at NCEP (ESRL, NCEP) • Vigorous effort leading complete package with extensive improvements,	Mar 2013

Deliverables	Delivery Schedule
summary at: http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2013.pdf	**COMPLETE**
b. Complete the testing of the 40/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data (GSD, CAPS) • Initial work completed by CAPS, testing of further enhancements to system. GSD testing and inclusion in RAPv2 of hybrid system with full observational data, using GFS ensemble data. Milestones exceed.	Mar 2013 **COMPLETE**
d. Report on early version of RAPv3 primary cycle at GSD with physics enhancements for initialization of the HRRR. (ESRL)	Dec 2013
e. Report on the optimal configurations for including satellite data in the 40/13 km dual-resolution hybrid system to ensure overall positive impacts of the data (NCEP, ESRL)	Dec 2013
f. Finalize RAP version to initialize experimental HRRR for 2014 real-time use toward operational HRRR (ESRL)	Mar 2014
g. Deliver progress report on development of NARRE (NCEP, ESRL)	Mar 2014
h. Deliver progress report on ensemble/hybrid data assimilation for use in NARRE (ESRL, NCEP)	Mar 2014
i. Subject to NCEP Directors' approval, upgrades to observation processing &/or quality control and/or GSI and/or NMMB systems become Operational at NCEP. (NCEP)	Mar 2014
j. Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. (NCAR-MMM)	Mar 2014

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

During May, GSD personnel were active in evaluating the recently updated and frozen HRRR system, during a period of active weather with several strong tornado outbreaks. Overall results were encouraging, with good depiction of storm structure at long lead-time (up to 12-h) and accurate short-term forecasts (0-3 h) of ongoing convection. This latter result indicates that the new HRRR pre-forecast hour with radar and convectional observation assimilation is doing a good job of greatly reducing the spin-up problem that has exited previously with the HRRR. The HRRR also did a very good job with convective initiation for several recent severe thunderstorm events, with a slight tendency to initiate too early and place storms a bit too far east.

During the period, three AMB personnel (John Brown, Eric James, and Curtis Alexander) traveled to Norman, OK and participated in the SPC spring program. During the week that each person spent there, they intensively analyzed high-resolution output from many models and gained good insight into HRRR performance characteristics. Fig. 1 below, shows a sample forecasts from the May 31, 2013 El Reno tornado that cause several fatalities west of Oklahoma City. As part of his visit to SPC, Curtis Alexander presented a seminar on the HRRR and related RAP improvements.

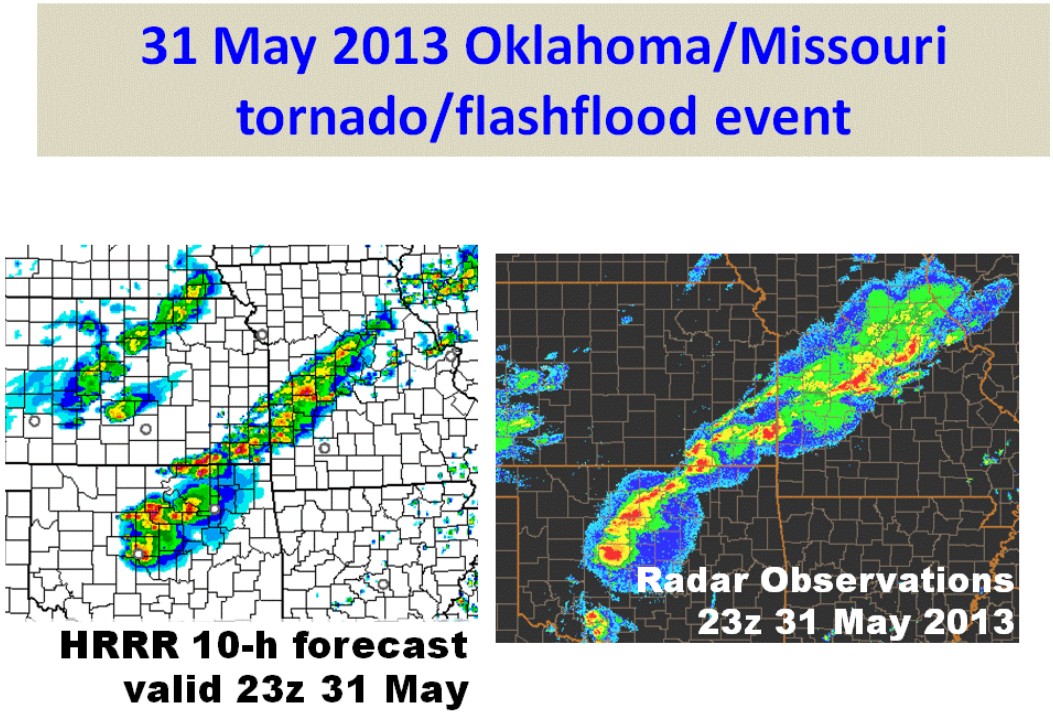

Fig. 1 (left) HRRR +10h forecast reflectivity valid 23z 31 May 2013. (Right) 23z 31 May 2013 radar observed reflectivity.

Curtis also continued his work to build a version of the HRRR with the full assimilation on WCOSS, in advance of a possible 2014 implementation. This version includes the full HRRR pre-forecast hour during which four consecutive periods of 15-min radar reflectivity assimilation are completed, followed by an application of the GSI 3DVAR analysis at 3km. As part of this test, WCOSS resource requirements for the HRRR with the full 3-km data assimilation are being determined.

Patrick Hofmann continued his work on the RTMA, by getting it running again in real-time on GSD computers. He is also working with Tracy Smith to convert GSD 15-min observation files (METAR, mesonet, etc.) to the GSI required prepBUFR format on a 15-min real-time basis. He is making good progress on this task to get a 15-min version of the HRRR-based RTMA running in near-real time.

NCEP

NCEP EMC and NCO conducted a planning exercise of what the modeling suite might look like on WCOSS Phase 1 and Phase 2. The size of the latter would be enhanced by the Sandy Supplemental funds. This plan incorporated ESRL/GSD along with all other contributors to the NCEP Production suite. NWS Director Louis Uccellini was briefed 28 March. While tentative, these plans called for HRRR implementation on Phase 1 and a HRRR Ensemble (HRRRE), combining multiple runs with configurations of both WRF-ARW and NMMB, on Phase 2. A sizable bank of computing was dedicated on Phase 2 to advanced data assimilation for the convective allowing scales of the HRRRE, likely involving a 4-dimensional version of the current GSI-hybrid-EnKF.

Deliverables	Delivery Schedule
Task 2 – Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	
a. Report on initial tests of 3-km 15-min RTMA cloud / surface analysis for use in frontal diagnostics, CI assessment and other near-surface assessments (ESRL, NCEP) • *Good progress toward 3km RTMA and RUA surface and cloud analyses* • *Successful initial tests summarized in report:* **http://ruc.noaa.gov/pdf/GSD_RTMA_report.pdf**	Feb 2013 COMPLETE
b. Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for 2013 real-time use (ESRL) • *Extensive set of enhancements in place and running in real-time experimental GSD RAPv2 / HRRR system*	Mar 2013 **COMPLETE**
c. Provide preliminary 15-min RTMA surface analyses as experimental improved basis for frontal diagnostics and other diagnostics from surface analyses (ESRL, NCEP) **Good progress on converting 15-min NetCDF files to prepBUFR format.**	Apr 2013 **Request delay to June 2013**
d. Report on computing resource status on NCEP Central Computing System, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR (NCEP, ESRL) Discussion toward possible 2014 implementation.	Jun 2013
e. Complete FY13 internal assessment with revised 3-km HRRR running every hour (ESRL)	Sept 2013
f. Provide revised 15-min RTMA surface analyses as primary basis for frontal diagnostics and other diagnostics from surface analyses for real-time use in 2014 (ESRL, NCEP)	Feb 2014
g. Finalize all changes to the HRRR for real-time use in 2014 (ESRL)	Mar 2014

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

To summarize from the last quarter report, extensive testing and evaluation of physics options for RAPv2 continuing through January and February into March led to the late March decision on the following physics configuration for RAPv2 used within the WRFv3.4.1 code:

- New 9-level configuration of the RUC land-surface model (RUC LSM)
- Mellor-Yamada-Nakanishi-Niino (MYNN) planetary-boundary- and surface-layer scheme in place of the current Mellor-Yamada-Janjic (MYJ) scheme.
- Continue use of the Grell G3 scheme from WRFv3.2.1.
- Continue use the Goddard short wave and RRTM long-wave radiation schemes.
- Use WRFv3.4.1 version of the Thompson microphysics.

As noted under Task 1, a notable cold bias showed up over areas of snow cover during April and early May. Investigation of this unexpected problem by Joe Olson and Tanya Smirnova led to the discovery that code that uses a special formulation for the roughness length for heat over snow cover (Andreas 2002, *J. Hydromet.*) introduced late last year had been inadvertently deactivated in late March. As a result, the coupling between the cold snow surface and the adjacent atmosphere was too large, resulting in the cold bias. The use of the Andreas formulation was restored in early May.

Also as noted under Task 1, a low-level daytime moist bias has shown up in the RAP primary cycle at GSD. This seems most pronounced in southerly flow in advance of cold fronts. Because in our parallel and retrospective testing with the MYNN PBL and surface layer scheme against the MYJ, the MYNN produced slightly drier conditions, this was not anticipated. As noted under Task 1, very recently we made a modification of our partial cycling that should reduce possible contamination from a too-moist GFS. If this fails to reduce the moist bias, deeper investigation will be required.

During May we initiated what we intend to be regular telecons with the land-surface group at NCEP headed by Mike Ek. The purpose of this exchange is to learn more about available land-surface datasets and other ongoing work in the land-surface modeling arena, both on the regional and global scales.

Test and evaluation of the Grell-Freitas convective parameterization was temporarily suspended in mid-May to accommodate data impact comparisons for the MPEX project (See Task 1). Georg Grell continues to analyze issues with the G-F scheme uncovered in RAP testing and we are not excluding its use in later versions of RAP.

The use of WRFv3.4.1 by default incorporates the NCAR (Greg Thompson) fix to allow attenuation of incoming solar radiation by clouds in the Goddard short-wave radiation scheme. So this is part of the RAP physics configuration used with the RAP-primary that feeds the HRRR for this summer's convection exercise.

GSD requests deferral of Deliverable 3.c (Request for Change for RAPv2 physics) from May to August 2013.
As described earlier under Task 1 efforts, testing is now underway for RAPv2 on the new NCEP WCOSS computer. But this date was inadvertently set too early.

NCEP

NCEP/EMC hosted a visit by Greg Thompson of NCAR/RAL from 20-23 May, during which he gave a seminar (20th) and interacted with modelers in the Mesoscale Modeling Branch, the Global Modeling Branch, and the Hurricane Group. Success was achieved in the goal of integrating his cloud microphysics into the NOAA Environmental Modeling System (NEMS) Nonhydrostatic Multiscale Model on B-grid (NMMB), and establishing a template for coupling his microphysics with the Rapid Radiation Transfer Model (RRTM) radiation package within NEMS. This achievement will allow additional collaborations in the future during which the sensitivity of forecast guidance quality to various cloud microphysics treatments will be examined. (Brad Ferrier)

NCAR/RAL

CURRENT EFFORTS: During the month of May, NCAR-RAL altered the technique to mimic surface aerosol emissions in a simple yet efficient and effective manner. Afterwards, we repeated three out of the previous six three-dimensional sensitivity experiments of a 72-hour storm period to ensure it worked properly and to create more realistic low-level final aerosol amounts. A more detailed analysis and preparation of a journal article describing the scheme and test results are ongoing.

FUTURE EFFORTS: Using the new code, we will investigate the sensitivity of aircraft icing due to cloud changes from altered aerosols. NCAR-RAL will work closely with colleagues at NOAA-GSD to transfer and guide code integration, especially more explicit coupling with their existing WRF-Chem model configuration.

PROBLEMS/ISSUES ENCOUNTERED: Conflicts for staff time on other projects remains challenging due to uncertain funding with government sequester, but we will work collaboratively with NOAA to support code integration.

INTERFACE WITH OTHER ORGANIZATIONS:
Alison Nugent (PhD student) and Ron Smith, Yale University
Yaitza Luna (PhD student), Howard University
Antonio Parodi, CIMA foundation, Italy

NCAR/MMM

Deliver a WRF Users' Workshop and WRF Tutorial for the User Community

NCAR continued preparing for the next WRF tutorial at its Foothills Lab, which will be July 15–26, 2013. This will include a basic WRF tutorial, a WRFDA tutorial, a WRF-Chem tutorial, and a WRF regional climate tutorial. The tutorial is described at: **http://www.mmm.ucar.edu/events/tutorial_137/index.php**.

NCAR has been organizing the 14th WRF Users' Workshop (**http://www.mmm.ucar.edu/events/2013_wrfusers/index.php**). This will be at NCAR's Center Green facility in Boulder on June 24–28. The agenda has been determined and will be posted shortly. In addition to three days of WRF-related presentations and discussions, it will feature a half-day of lectures on radiation and effects of clouds, ozone, and aerosols. The final day will feature tutorial-type sessions on packages such as WRF-Hydro, NCL, and VAPOR.

PLANNED EFFORTS: NCAR will continue to prepare both the 14th WRF Users' Workshop and the summer WRF tutorial.

UPDATES TO SCHEDULE: NONE

Incorporate Physics and Dynamics Improvements into WRF

Jimy Dudhia of NCAR/MMM worked with Pedro Jimenez and Raquel Lorente (Univ. of Murcia, Spain) on evaluating diurnal errors in WRF surface wind simulations and finding improvements in the topo_wind parameterization. It is found that the topo_wind scheme underpredicts wind in day-time conditions, so the aim is to reduce its effect there.

Dudhia began collaborating with NCAR visitor Esa-Matti Tastula (U. South Florida) on evaluating the QNSE-EDMF PBL scheme. This scheme has shown a problem of too-little daytime mixing in 1d tests. This is being examined in single-column configuration and real-data tests.

Dudhia continued working with Jose Ruiz-Arias (Univ. of Jaen) on improving solar radiation computational methods. Ruiz-Arias has found a way to change SWDOWN more gradually without having to call the solar radiation more frequently, just by using the timestep sun-angle computation. The goal is to reduce the step effect of the radiation call frequency.

Dudhia continued collaborating with Stephanie Evan (NOAA/ESRL) on WRF simulations of the tropical tropopause layer (TTL). They are working on modifications to the WSM5 scheme to improve the TTL cold-point water vapor. This had a dry bias, and they are looking at a remaining cold bias.

Dudhia and Wei Wang (NCAR/MMM) corrected a problem in WRF involving jumps in time-series 2m dewpoint temperature. This was related to a conditional statement in the code that is no longer needed. A fix has been implemented in the WRF repository version.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RAP will continue through FY13Q3.

UPDATES TO SCHEDULE: NONE

Deliverables	**Delivery Schedule**
Task 3 – Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	**Delivery Schedule**
a. Complete initial evaluation of aerosol-aware microphysics in RAP real-time cycling at GSD for its suitability as part of the RAPv3 prototype for 2014 NCEP	Delay until funding

implementation (NCAR-RAL, ESRL)	restored to NCAR
b. Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package to be implemented at NCEP by spring 2014 (ESRL, NCEP) • Freeze of model physics code for March 2013 version of RAP at ESRL allows this milestone to be met.	Mar 2013 **COMPLETE**
c. Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v2 software to NCO (NCEP, ESRL)	May 2013 **Request defer to Aug 2013**
d. Transfer upgraded coupled aerosol-microphysics scheme into a test version of HRRR (NCAR-MMM, ESRL)	Dec 2013
f. Finalize microphysics changes and other physics changes to improve icing forecasts for ESRL version of RAP and HRRR for 2014 real-time use (ESRL)	Mar 2014
g. Report summary of icing probability skill measures by quarter for the year. (NCEP)	Mar 2014

Task 4: Develop convection-ATM-specific improvements for guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

Task 4 – Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL)

A correction was applied to the HRRR (and RAP) precipitating hydrometeor analysis to clear entire model columns if radar reflectivity observations indicated no precipitation in regions of a model column with radar coverage and satellite observations indicated an entirely clear column. This correction removes model-precipitating hydrometeors from portions of the model column outside radar coverage to provide a more physically consistent hydrometeor analysis and initial condition for the HRRR forecast. The correction reduces the diagnosed HRRR reflectivity (and VIL) bias at lower thresholds for the initial time and into the early portions of the forecast period.

Task 4 – Assess HRRR reliability and provide monthly reporting (ESRL)

Current:
Work has focused on monitoring the HRRR forecast production for high reliability including completion of the file failover capability. This failover capability was successfully tested with parallel HRRR files from the Zeus HRRR-dev transferred back to GSD and distributed in real-time. This failover was completed in spite of a somewhat slow file transfer speed between the EMC computer and the GSD computers.

HRRR Reliability for 0-8 Hour VIL/Echo Tops for May 2013

Jet
All runs: 92.9%
3 or more consecutive missed runs: 97.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 99.3%
7 outages of at least 3 hrs. or longer
1 outage of at least 6 hrs. or longer

Zeus
All runs: 64.2%
3 or more consecutive missed runs: 78.4% (most meaningful for CoSPA)
6 or more consecutive missed runs: 85.2%
24 outages of at least 3 hrs. or longer
9 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 95.6%
3 or more consecutive missed runs: 98.3% (most meaningful for CoSPA)
6 or more consecutive missed runs: 99.3%
3 outages of at least 3 hrs. or longer
1 outage of at least 6 hrs. or longer

Planned:
Final work on distribution of HRRR model forecast data to ESRL/GSD from Zeus without using Jet resources, allowing for a completely redundant real-time experimental HRRR system. A hardware upgrade to the ESRL firewall in July will permit sufficient bandwidth to distribute all HRRR model forecast data to ESRL/GSD directly from Zeus in a timely manner. Requests for dedicated computer reservations on Zeus, to further increase the reliability of the HRRR, are being submitted.

Task 4 – Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014

Tracy Smith ported SatCast assimilation code (previously developed for use with the RUC analysis) from the RUC to the RAP (GSI package). The code ingests SatCast IR cloud-top cooling data and maps it into a local heating function that is applied to the RAP fields in a similar manner to the way the RAP assimilates radar reflectivity data. Using a sample IR cloud-top cooling rate data set from a convectively active period in early July 2012, she completed a preliminary 1-day retrospective experiment (control run without the SatCast data and experiment with the SatCast data). Preliminary results indicate that for a scattered thunderstorm situation over the Southeastern U.S., assimilation of the SatCast IR cooling rates leads to a better short-term prediction of small-scale convective systems. Further work is ongoing.

Task 4 – Interact with CoSPA (or other) program partner labs and the FAA

Team (ESRL/GSD, NCAR/RAL, and MIT/LL) telecons and e-mail correspondence have and will continue to occur to discuss issues related to the HRRR reliability including scheduled outage periods during the CoSPA 2013 season.

Deliverables	**Delivery Schedule**
Task 4 – Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA	
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL) • Code for revised echo-top / reflectivity diagnostics with revised microphysics implemented in GSD real-time HRRR.	Mar 2013 **COMPLETE**
Conduct baseline testing of the early 2013 HRRR version (ESRL) • Baseline testing of 2013 HRRR version completed as part of code preparation for freeze. Summary of skill score improvements being prepared.	Mar 2013 **COMPLETE**
Report on evaluation of new microphysics scheme and associated echo-top and	Mar 2013

reflectivity diagnostics in ESRL/GSD RAP and HRRR (ESRL) • *Preliminary evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_reflectivity_report.pdf**	**COMPLETE**
Assess HRRR reliability and provide monthly reporting (ESRL) Reliability statistics are being reported each month	*Apr 2013* **COMPLETE** *(ongoing)*
Report on evaluation of revised WRFv3.4 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL)	Mar 2014
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use of HRRR (ESRL)	Mar 2014
Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014 (ESRL)	Mar 2014
Report on 2014 baseline testing of the HRRR (ESRL)	Mar 2014